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(71) Applicant(s)
Kvaerner Oil & Gas Limited
(Incorporated in the United Kingdom)
Davis House, 69-77 Robert Street, High Street,
CROYDON, Surrey, CRO OYA, United Kingdom

(72) Inventor(s)
Michael Timothy Smith
John William Waddell

(74) Agent and/or Address for Service
Sam Briddes
Kvaerner Earl and Wright, Portland House, Stag Place,
LONDON, SW1E 5BH, United Kingdom

(54) Abstract Title
Substructure for an offshore platform and method of installation

(57) A substructure for an offshore platform, the substructure comprising a single straight elongate thin-walled tube (11) having open ends (12, 14), a plurality of controllably ballastable compartments (15) spaced apart longitudinally along the axis of the tube between the open ends of the tube, and control means to flood the compartments so that the tube can first be upended from a stable floating horizontal attitude to a stable floating vertical attitude, and can then be set down to stand on the seabed in a vertical attitude.

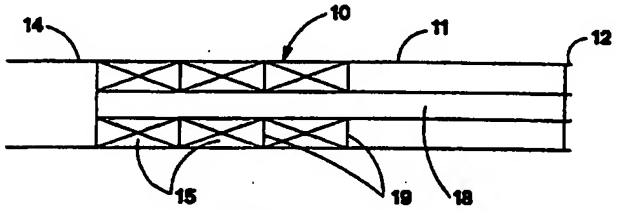

FIG 1

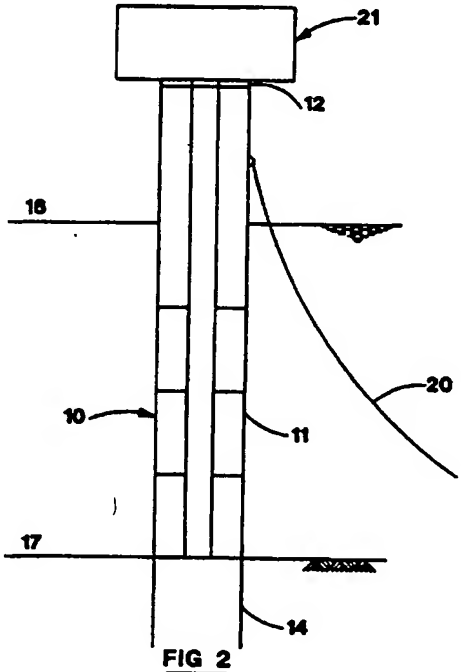

FIG 2

GB 2 323 619 A

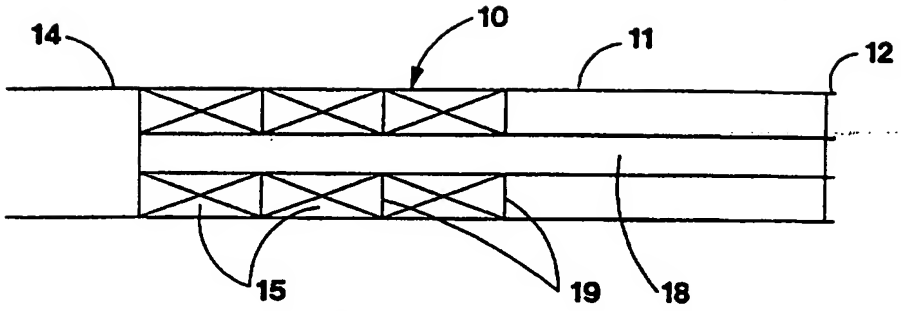

FIG 1

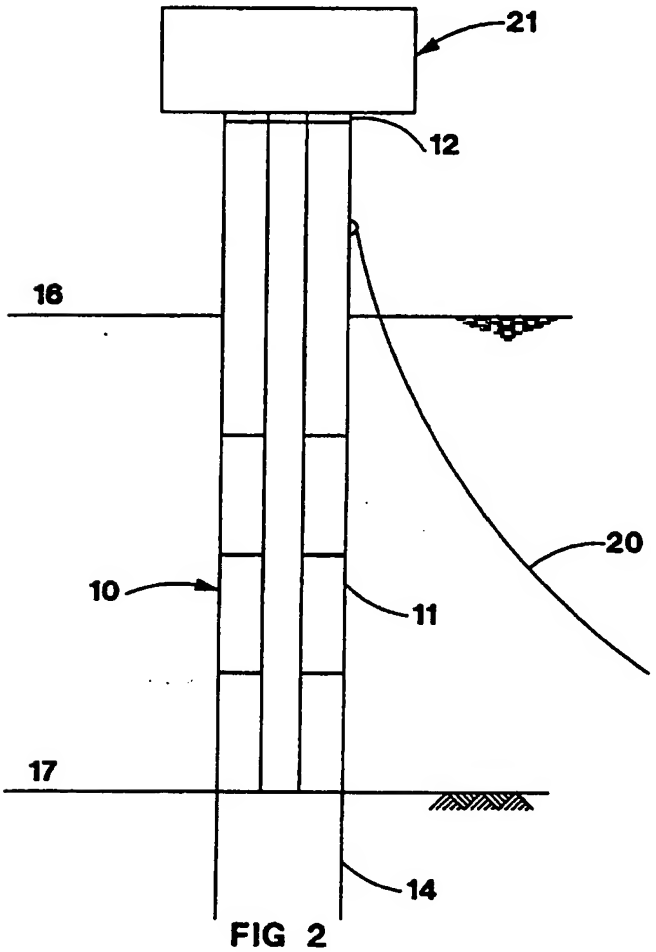

FIG 2

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SUBSTRUCTURE AND METHOD OF INSTALLATION

The invention relates to a substructure for an offshore platform, and to a method of installing such a substructure.

More particularly the invention relates to a self installing substructure for an oil and/or gas drilling and production platform to be located offshore; and to a method of installing such a substructure.

The transportation and installation of substructures for offshore platforms is a highly specialised activity. The cost of transporting substructures to their intended locations, and then installing them securely on the seabed, can form a substantial portion of the total cost of an offshore development.

This is particularly so in respect of substructures for small offshore platforms in relatively shallow waters, such as for the gas fields in the southern North Sea.

Transportation and installation activities related to substructures can also contribute significant costs to the development of oil or gas fields in deeper waters.

In our UK Patent 2,272,930 we have described and claimed a single leg Tension Leg Platform (TLP). This has a single column held under tension by the buoyancy of a floating hull at its upper end. Ballast is required near the base of the column to resist tension in the column created by the buoyancy of the hull. This type of substructure requires the use of a Heavy Lift Vessel (HLV) to implement its installation.

It has been known to use "spar buoy" substructures. The Brent Spar was perhaps the best known substructure of this type in the North Sea That substructure was positively buoyant, and was not used for production wells extending down into the seabed strata.

For water depths of 150m - 200m in the northern North Sea it has been known to use self floating substructures for fixed platforms. Examples are the substructures for the Thistle, Ninian Southern and Magnus platforms. A typical self floating substructure had two large diameter flotation legs. These flotation legs were spaced apart in parallel relationship. They were joined with complex lattice framing to two non-flotation legs, so to form a four legged substructure which could float to its intended location on the flotation legs. After upending, all four legs were piled to the seabed.

Predicted motions of this type of self floating substructure while afloat in rough seas led to severe transportation design cases (to resist wave and swell induced forces). Accordingly these self floating substructures required large amounts of steel just to form buoyancy and to resist the induced forces during transporation. For this reason, barge launched and twin lifted substructures (jackets) have become the accepted norm for medium sized and large offshore platforms. These barge launched and twin lifted jackets incur substantial installation costs.

There is currently a requirement for minimal topsides platforms. These may be used for exploiting small deposits of oil or gas near to established offshore processing facilities. It has recently been proposed to have substructures with single water-piercing legs to support lightweight topsides. Substructures with single water piercing legs have been driven directly into the seabed; or secured to the seabed with piles driven into the seabed through pile sleeves around their bases (as shown in US Patent 5,127,767). The need for an offshore installation spread including pile driving equipment has proved costly.

The transportation, installation and piling of substructures has been a major cost element in the development of offshore oil and gas deposits. For this reason it is desirable to simplify the installation procedure.

The invention provides a substructure for an offshore platform, the substructure comprising a single straight elongate thin-walled tube having open ends, a plurality of controllably ballastable compartments spaced apart longitudinally along the axis of the tube between the open ends of the tube, and control means to flood the compartments so that the tube can first be upended from a stable floating horizontal attitude to a stable floating vertical attitude, and can then be set down to stand on the seabed in a vertical attitude.

It is preferred that there are attachments for at least three guy wires spaced around the external periphery of the open end of the tube that is to form the upper end of the substructure.

It is also preferred that the open end of the tube that is to form the upper end of the substructure is configured to support a deck.

In one form it is preferred that the open end of the tube that is to form the lower end of the substructure is configured to penetrate into the seabed to form a 'bucket' foundation.

In this last mentioned form it is further preferred that there is means to create suction within the bucket foundation to draw the lower end of the tube downwardly into the seabed

The open end of the tube that is to form the lower end of the substructure maybe configured to fit over, or 'dock' onto, a preinstalled seabed structure (e.g. a pile or wellhead).

It is preferred that the controllably ballastable compartments are located around the periphery of the tube.

In one form it is preferred that there is a riser duct within the tube, the arrangement being such that the riser duct extends along the tube between the open ends.

In this last mentioned form it is further preferred that the riser duct is centrally located within the tube.

The tube may have a circular cross section; or may be of non uniform cross section axially along its length; and may have varying external dimensions axially along its length

The invention includes a substructure having attachments for guy wires when installed on a seabed and supported laterally with guy wires connected to the attachments and to the seabed surrounding the tube.

The invention also includes an offshore platform incorporating a substructure of the kind described above.

The invention also provides a method of installation of a substructure as described above comprising the steps of floating the tube in a horizontal attitude to its intended location, selectively and progressively flooding the controllably ballastable compartments to upend the tube into a vertical attitude and then flooding the or further ballastable compartments to set the tube down to stand on the seabed in a vertical attitude.

In a preferred form the invention includes the additional step of connecting guy wires to the attachments and to spaced points on the seabed surrounding the tube.

A specific embodiment of the invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 is a diagramatic longitudinal cross section of a substructure for an offshore platform, shown in its orientation for fabrication, transportation and installation;

Figure 2 is a sketch showing the post installed attitude of the substructure of Figure 1, with a topsides set thereon.

A substructure 10 for an offshore platform comprises a straight elongate thin walled tube 11. The tube 11 has open ends 12 (at its upper end) and 14 (at its lower end). Within the tube there are controllably ballastable compartments 15. These compartments are spaced apart longitudinally along the axis of the tube by bulkheads 19. The tube 11 is dimensioned so that when installed its upper end 12 is above sea level (16), and the lower end 14 extends down into the seabed (17). When unballasted, the substructure 10 is self buoyant.

The drawings are not necessarily to scale. In a water depth of 30m the tube may extend for 10m above the water line 16 and may extend down for 6m into the seabed 17.

The upper end 12 of the tube 11 is configured to support a deck for the platform topsides (not shown in Figure 1).

The lower end 14 of the tube 11 is configured to penetrate into the seabed 17 as a 'bucket' foundation. There may be pipework (not shown) within the tube whereby water can be pumped out from the bucket foundation, so to draw the lower end of the tube downward into the seabed.

Penetration of the lower end of the tube into the seabed will be very dependent upon the seabed strata. In order to stabilise the tube when only a small depth of penetration is possible, guy wires (e.g. 20) may extend downwardly and outwardly from near the upper end of the tube, into the seabed some way away from the lower end of the tube.

The central portion of the tube has peripheral watertight compartments 15, surrounding a central riser duct 18. This riser duct extends between the open ends of the tube 11. Drilling of production wells, can be carried out through this duct.

In use the substructure 10 can be self installing, thus eliminating the need for an offshore installation spread including costly lifting and piling equipment. As shown in Figure 1, the tube 11 is towed to its intended location horizontally in an unballasted condition. At the intended location the compartments 15 are selectively and progressively ballasted to upend the tube into a vertical attitude. Selective and progressive ballasting of the longitudinally spaced compartments enables the tube to be upended without excessive stress due to bending.

As shown in Figure 2, further ballasting then sets the tube down on the seabed with its open lower end 14 penetrating into the seabed strata. If necessary, additional penetration may be achieved by pumping the water out of the space between the peripheral wall of the tube, the bulkhead above the open lower end, and the seabed.

When the substructure 10 has been firmly founded on the seabed, and if necessary stayed against sideways movement using guy wires, the topsides can be installed. As shown in Figure 2, a deck 21 is supported between barges, and is floated over the upper end 12 of the tube 11. The deck 21 can then be lowered or pulled down on to the upper end 12 of the tube 11 forming the substructure 10, thus to complete the offshore platform.

CLAIMS

1. A substructure for an offshore platform, the substructure comprising a single straight elongate thin-walled tube having open ends, a plurality of controllably ballastable compartments spaced apart longitudinally along the axis of the tube between the open ends of the tube, and control means to flood the compartments so that the tube can first be upended from a stable floating horizontal attitude to a stable floating vertical attitude, and can then be set down to stand on the seabed in a vertical attitude.

2. A substructure as claimed in Claim 1 in which there are attachments for at least three guy wires spaced around the external periphery of the open end of the tube that is to form the upper end of the substructure.

3. A substructure as claimed in Claim 1 or Claim 2 in which the open end of the tube that is to form the upper end of the substructure is configured to support a deck.

4. A substructure as claimed in any one of the preceding claims in which the open end of the tube that is to form the lower end of the substructure is configured to penetrate into the seabed to form a 'bucket' foundation.

5. A substructure as claimed in claim 4 in which there is means to create suction within the bucket foundation to draw the lower end of the tube downwardly into the seabed

6. A substructure as claimed in any one of the preceding claims in which the open end of the tube that is to form the lower end of the substructure is configured to fit over, or 'dock' onto, a preinstalled seabed structure (e.g. a pile or wellhead).

7. A substructure as claimed in any one of the preceding claims in which the controllably ballastable compartments are located around the periphery of the tube

8. A substructure as claimed in any one of the preceding claims in which there is a riser duct within the tube, the arrangement being such that the riser duct extends along the tube between the open ends.

9. A substructure as claimed in Claim 8 in which the riser duct is centrally located within the tube.

10. A substructure as claimed in any one of the preceding claims in which the tube has a circular cross section.

11. A substructure as claimed in any one of Claims 1 to 9 in which the tube is of non uniform cross section axially along its length.

12. A substructure as claimed in any one of the preceding claims in which the tube has varying external dimensions axially along its length

13. A substructure as claimed in any one of Claim 2 and Claims 3 to 12 as dependant on Claim 2, when installed on a seabed and supported laterally with guy wires connected to the attachments and to the seabed surrounding the tube.

14. A substructure substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

15. An offshore platform incorporating a substructure as claimed in any one of the preceding claims.

16. A method of installation of a substructure as claimed in any one of the preceding Claims 1 to 14 comprising the steps of floating the tube in a horizontal attitude to its intended location, selectively and progressively flooding the controllably ballastable compartments to upend the tube into a vertical attitude and then flooding the or further ballastable compartments to set the tube down to stand on the seabed in a vertical attitude.

17. A method as claimed in Claim 16 of installation of a substructure as claimed in any one of Claim 2 and Claims 3 to 12 as dependant on Claim 2, comprising the additional step of connecting guy wires to the attachments and to spaced points on the seabed surrounding the tube.

18. A method substantially as hereinbefore described with reference to the accompanying drawings.

The Patent Office

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Claims searched:	1-18	**Date of search:**	21 July 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): E1H (HB, HEA, HEE, HEF) : B7A (AAAQ)

Int Cl (Ed.6): E02B 17/00, 17/02 : B63B 35/00, 35/44

Other: Online:WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	GB 1530732 (SEA TANK CO) See eg Figs 6-10	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.